

DEVICE AND METHOD FOR SCRAMBLING/DESCRAMBLING VOICE AND DATA FOR MOBILE COMMUNICATION SYSTEM

BACKGROUND OF THE INVENTION

5 1. Field of the Invention

The present invention relates to vocoding voice and data in a mobile communication system and, more particularly, to a device and method for scrambling/descrambling voice and data for a mobile communication system whereby communication signals on a cable channel can be scrambled and descrambled
10 irrespective of the operational mode of a system vocoder in a digital mobile communication system during voice data transmission between mobile stations with the vocoder.

2. Description of the Related Art

Generally, voice is transmitted after compression in a digital mobile
15 communication system in order to support a large number of mobile stations within a limited capacity of radio channels. For voice compression, there is used a voice scrambling algorithm, normally, a vocoding algorithm in the field of the mobile communication system because the vocoding algorithm is characterized by low data rate and voice quality for the cable network. The vocoding algorithm, which is an error-
20 containing algorithm, produces more errors between the restored voice and the original one with an increase in the number of iterative compression and restorations. That is, the tone quality of the restored voice deteriorates.

Fig. 1 is a diagram for explaining interval-based transmission of voice and data

between mobile stations in a general mobile communication system.

As illustrated in the figure, when an originating mobile station 1 compresses voice and transmits the compressed voice to a transport station 2 in the form of packet, then a vocoder (not shown) in the transport station 2 restores the packet to data in the PCM (Pulse Code Modulation) form. The PCM data are sent to a transport station 2' serving a target mobile station 1' via an exchange 3 and then recompressed at the vocoder provided in the transport station 2'. Here, the transport station 2 includes a base station controller and a base station. The compressed packet is sent to the target mobile station 1' via a radio channel.

10 The mobile station 1' restores the received packet with an internal vocoder. Through these procedures, the mobile station can receive voice from the originating mobile station.

Finally, the voice undergoes two vocoding steps during transmission between the two mobile stations. In this event, the voice packet compressed and transmitted from the originating mobile station 1 via a radio channel is packet-bypassed at the system vocoder, thereby reducing the number of vocoding steps and decreasing deterioration of tone quality. This packet bypass process is also utilized in data transmission. Here, between the mobile station 1 or 1' and the transport station 2 or 2' is the radio channel interval and between the transport station 2 or 2' and the exchange 3 is the cable channel interval.

20 Now, a description will be given to a device for vocoding voice signals according to prior art with reference to Fig. 2.

Fig. 2 presents the patterns of a packet bypassed at the vocoder in a general mobile communication system, wherein Fig. 2a shows the format of the bypassed voice

packet and Fig. 2b shows the format of the bypassed data packet. Fig. 3 is a schematic block diagram of a vocoding device in the respective operational modes in a mobile communication system according to prior art.

First, the vocoding device in the mobile communication system includes a
5 vocoder 20 and an upper processor 10. The upper processor 10 includes the entire of the transport stations 2 and 2' and the exchange 3, except the vocoder 20.

The vocoder 20 includes first to fourth mode switching blocks 22, 26, 27 and 31 and first to sixth vocoding processors 23, 24, 25, 28, 29 and 30 for performing a mode-based vocoding.

10 The above-configured vocoding device in the mobile communication system according to the prior art operates in three operational modes during data transmission between the mobile stations.

The first operational mode is enabled when the vocoders in the mobile stations are distinct, for example, 8 Kbps EVCR (Enhanced Variable Code Rate) and 13 Kbps
15 QCELP (Qualcomm Code Excited Linear Predictive) vocoders, in which mode the system vocoders perform a normal vocoding process, i.e., voice scrambling and descrambling. In this event, the pattern of the transmission data is packet data on the radio channel (i.e., a transmission line between the mobile station and the system vocoder), and PCM data on the cable channel (i.e., a transmission line between the
20 system vocoders between which the exchange is interposed).

The second operational mode is enabled when the vocoders in the mobile stations are identical, for example, EVCT vocoders or QCLP vocoders, in which case the system vocoders operate in a voice packet bypass mode. In this event, the pattern of the

transmission data is packet data on the radio channel, and bypassed voice packet data as shown in Fig. 2a on the cable channel.

The third operational mode is enabled during data transmission between the mobile stations, in which mode the system vocoders operate in a data packet bypass mode. In this event, the pattern of the transmission data is packet data on the radio channel, and bypassed data packet as shown in Fig. 2b on the cable channel.

The conventional vocoding system operating in the above-stated three operational modes is illustrated in Fig. 3.

As show in Fig. 3, the vocoder 20 receives mode information "E" from the upper processor 10 and operates in the corresponding mode under the control of the mode controller 21.

For example, when the vocoder 20 receives the first mode information from the upper processor 10, the mode controller 21 switches the switching blocks 22 and 26 to the first vocoding processor 23, which vocodes voice packet data transferred from the originating mobile station via a radio channel "A" into PCM data and sends the PCM data to the exchange via a cable channel "C". The mode controller 21 also switches the switching blocks 27 and 31 to the fourth vocoding processor 28, which vocodes the PCM data transferred from the exchange via a cable channel "D" into packet data and sends the packet data to the target mobile station via a radio channel "B".

If the vocoder 20 receives the second mode information from the upper processor 10, the mode controller 21 switches the switching blocks 22 and 26 to the second vocoding processor 24, which bypasses voice packet data transferred from the originating mobile station via the radio channel "A" and sends the bypassed voice packet

data to the exchange via the cable channel "C". The mode controller 21 also switches the switching blocks 27 and 31 to the fifth vocoding processor 29, which bypasses voice packet data transferred from the exchange via the cable channel "D" and sends the bypassed voice packet data to the target mobile station via the radio channel "B".

5 When the vocoder 20 receives the third mode information from the upper processor 10, the mode controller 21 switches the switching blocks 22 and 26 to the third vocoding processor 25, which bypasses data packet transferred from the originating mobile station via the radio channel "A" and sends the bypassed data packet to the exchange via the cable channel "C". The mode controller 21 also switches the switching
10 blocks 27 and 31 to the sixth vocoding processor 30, which bypasses data packet transferred from the exchange via the cable channel "D" and sends the bypassed data packet to the target mobile station via the radio channel "B".

As such, the vocoder 20 communicates packets on the radio channels "A" and "B" as well as mode information with the upper processor 10 to perform an adequate
15 processing based on the mode information, and communicates bypassed packet data and PCM data as shown in Fig. 2 on the cable channels "C" and "D" based on the operational mode.

The upper processor 10 not only controls the vocoder 20 but also enables packet communication between the mobile station and the system vocoder through the radio
20 channels.

However, the vocoding system according to the prior art involves a problem in that the voice data on the cable channels are susceptible to overhearing while the system vocoders is operating in the respective modes.

For example, in the first operational mode, i.e., normal vocoding mode, the PCM data on the cable channels are ready to be overheard by an overhearing instrument.

In the second operational mode, i.e., voice packet bypass mode, the bypassed voice packet data are not easy to overhear by a general PCM overhearing method but susceptible to overhearing, because the voice packets are positioned in the predefined fields in a given order, as shown in Fig. 2a, with a limited number of cases for finding a specific voice packet among the entire bypassed voice packets at a position.

In the third operational mode, i.e., data packet bypass mode, the data packets can be extracted simply by eliminating a flag field having the same pattern, because the bypassed data packets iteratively appear on the cable channels, as shown in Fig. 2b.

SUMMARY OF THE INVENTION

It is, therefore, an object of the present invention to provide a device for scrambling/descrambling voice and data in a mobile communication system, in which a transmitter system vocoder has an scrambling function to scramble a communication signal on a cable channel and a receiver system vocoder has a descrambling function to descramble the scrambled data, thereby preventing overhearing of the voice data.

It is another object of the present invention to provide a method for scrambling/descrambling voice and data corresponding to the operation of the vocoder.

Specifically, the object of the present invention is to provide a device and method for scrambling/descrambling voice and data in a mobile communication system, in which the system vocoders are provided with a scrambler and a descrambler to scramble a communication signal and descramble the scrambled signal using the same scrambling key received from the upper processor, in order to prevent overhearing of voice and data

drain on cable channels.

To achieve the above object of the present invention, in a voice/data vocoding device for a mobile communication system, a device for scrambling voice and data in the mobile communication system includes: a controller for generating an operational mode control signal to control an operational mode of the voice and data, a scrambling key feeding control signal to control data scrambling, and a sync signal generation control signal; an operational mode processor for vocoding or bypassing a voice/data packet received from a radio channel interval, based on the operational mode control signal of the controller; a random number generator for generating a random number based on the scrambling key feeding control signal of the controller; a sync signal transmitter for generating a sync signal based on the sync signal generation control signal of the controller, and sending the generated sync signal to a cable channel interval; and a scrambler for scrambling a vocoded PCM (pulse code modulation) signal or a bypassed voice/data packet of the operational mode processor using the random number generated from the random number generator and, after complete transmission of the sync signal, sending the scrambled PCM signal or voice/data packet to the cable channel interval.

In another aspect of the present invention, there is provided a device for descrambling voice and data in a mobile communication system including: a sync signal detector for detecting a sync signal from an scrambled signal received from a cable channel interval; a controller for generating a descrambling control signal, an operational mode control signal, and a descrambling key feeding control signal, upon detection of the sync signal at the sync signal detector; a random number generator for generating a random number based on the descrambling key feeding control signal of the controller; a

descrambler for descrambling the scrambled signal received from the cable channel interval using the random number generated from the random number generator, based on the descrambling control signal of the controller; and an operational mode processor for vocoding a descrambled PCM signal of the descrambler into a packet or bypassing a voice/data packet, based on the operational mode control signal of the controller, and then sending the vocoded PCM signal or the bypassed voice/data packet to a radio channel interval.

In further another aspect of the present invention, there is provided a device for scrambling/descrambling voice and data in a mobile communication system including:

10 an operational mode processor for vocoding or bypassing a voice/data packet received from a radio channel interval based on a received operational mode signal, and vocoding or bypassing a descrambled PCM signal or packet based on the operational mode signal; a random number generator for generating a random number based on a received scrambling and descrambling key feeding control signal; a sync signal transmitter for

15 generating a sync signal based on a received control signal, and sending the generated sync signal to a cable channel interval; a scrambler for scrambling the vocoded PCM signal or the bypassed voice/data packet of the operational mode processor using the random number generated from the random number generator and, after complete transmission of the sync signal, sending the scrambled PCM signal or voice/data packet

20 to the cable channel interval; a sync signal detector for detecting a sync signal from the scrambled signal received from the cable channel interval; a descrambler for descrambling the scrambled signal received from the cable channel interval using the random number generated from the random number generator, based on a received

descrambling control signal; and a controller for generating the descrambling control signal to the descrambler, the scrambling and descrambling key feeding control signal, and the sync signal generation control signal, upon detection of the sync signal at the sync signal detector.

5 In still further another aspect of the present invention, there is provided a method for scrambling voice and data in a mobile communication system including the steps of: vocoding or bypassing a voice/data packet received from a radio channel interval based on a received operational mode signal; generating a defined random number based on scrambling key information; generating a sync signal and sending the
10 generated sync signal to a cable channel interval; and upon complete transmission of the sync signal, scrambling the mode-processed signal (including a PCM signal, or bypassed voice/data packet) using the random number and sending the scrambled signal to the cable channel interval.

In still further another aspect of the present invention, there is provided a
15 method for descrambling voice and data in a mobile communication system including the steps of: receiving an scrambled signal from a cable channel interval; upon receiving the scrambled signal, detecting a sync signal from the scrambled signal; upon detection of the sync signal, generating a random number based on a descrambling key signal; descrambling the scrambled signal using the random number; and vocoding a
20 descrambled PCM signal or bypassing a descrambled packet based on an operational mode signal, and sending the vocoded PCM signal or the bypassed packet to a radio channel interval.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a diagram for explaining interval-based transmission pattern between mobile stations in a general mobile communication system;

Fig. 2 presents the bypassed packet pattern of a vocoder in a general mobile communication system, wherein Fig. 2a shows the format of a bypassed voice packet and

5 Fig. 2b shows the format of a bypassed data packet;

Fig. 3 is a schematic block diagram of the vocoding device based on an operational mode in a mobile communication system according to prior art;

Fig. 4 is a schematic block diagram of a device for scrambling/descrambling voice and data in a mobile communication system according to the present invention; and

10 Figs. 5a and 5b are flow charts for explaining a method for scrambling/descrambling voice and data in a mobile communication system according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Hereinafter, a detailed description will be given to a device and method for
15 scrambling/descrambling voice and data in a mobile communication system according to the present invention with reference to the accompanying drawings.

First, in the present invention, there are three patterns of the communication signal delivered on cable channels according to the operational mode of a system vocoder during communication between mobile stations. That is, in the voice
20 communication, the transmission data has a pattern of PCM signal when the system vocoder operates in a normal vocoding mode, and bypassed voice packet when the system vocoder operating in a voice packet bypass mode.

Meanwhile, in the data communication, the system vocoder operates in a data

packet bypass mode and the transmission data has a pattern of bypassed data packet on the cable channels.

The present invention enables a scrambling/descrambling operation for all patterns of the transmission data.

5 Fig. 4 is a schematic block diagram of a vocoding system for scrambling/descrambling voice/data in a mobile communication system according to the present invention.

As illustrated in the figure, the vocoding system comprises: an upper processor 30 for providing operational mode information and scrambling key information; an
10 operational mode processor 41 for processing voice/data packet received on a radio channel "A" from an originating mobile station in a vocoding mode or a bypass mode based on the operational mode information received from the upper processor 30, or processing descrambled signals as a packet in the vocoding mode or the bypass mode, and sending the processed packet to a target mobile station via a radio channel "B"; a
15 controller 42 for storing the scrambling key information received from the upper processor 30, and generating a scrambling key information storage control signal, a scrambling key information output control signal, a sync signal transmission control signal and a switching control signal to output the stored scrambling key; and a
scrambling key seed block 45 for storing the scrambling key information received from
20 the upper processor based on the storage control signal from the controller 42, and outputting the stored scrambling key information based on the output control signal.

The vocoding system further comprises: a first switching block 43 for switching the operational mode from a normal mode to a scrambling mode based on the control

signal received from the controller 42; a random number generator 46 for generating a random number based on the scrambling key information received from the scrambling key seed block 45; a scrambler 47 for scrambling the packet or PCM signal mode-processed (i.e., vocoded or bypassed) at the operational mode processor 41 based on the
5 random number generated from the random number generator 46; a sync signal transmitter 44 for generating and sending a sync signal based on the sync signal transmission control signal received from the controller 42; and a second switching block 48 for sending the sync signal received from the sync signal transmitter 44 and then switching the scrambled signal from the scrambler 47, thereby sending the scrambled
10 data to an exchange via a cable channel "C".

The vocoding system further comprises: a sync signal detector 49 for detecting a sync signal from the scrambled signal received via a cable channel "D"; a third switching block 50 for switching the operational mode from a normal mode to a descrambling mode based on the control signal of the controller 42, upon detection of the sync signal at
15 the sync signal detector 49; and a descrambler 51 for descrambling the scrambled signal received based on the switching operation of the third switching block 50, and sending the descrambled signal to the operational mode processor 41.

A detailed description will now be given to an operation of the above-structured voice/data scrambling/descrambling device in a mobile communication system according
20 to the present invention.

First, the vocoder 40 receives operational mode information "E" and scrambling key information "F" from the upper processor 30. Then, the operational mode processor 41 and the controller 42 in the vocoder 40 generate various control signals.

That is, the controller 42 stores the scrambling key in the scrambling key seed block 45 and outputs the stored scrambling key read out from the scrambling key seed block 45 to the random number generator 46. The controller 42 also switches the first switching block 43 from stage "a" to stage "g".

5 The random number generator 46 generates a random number based on the scrambling key received from the scrambling key seed block 45 and applies the generated random number to the scrambler 47.

10 According to the switching operation of the first switching block 43, the scrambler 47 scrambles the bypassed packet or vocoded PCM signal received from the operational mode processor 41 based on the random number received from the random number generator 46, and outputs the scrambled packet or PCM signal to the second switching block 48.

15 The controller 42 provides a control signal to the sync signal transmitter 44 and a switching control signal to the second switching block 48 so as to send the sync signal of the sync signal transmitter 44 to the cable channel interval. Once the sync signal is sent to the cable channel interval, the controller 42 switches from the second switching block 48 to the scrambler 47 to send the scrambled signal from the scrambler 47 to the cable channel interval.

20 Here, the sync signal is transmitted once prior to sending the scrambled signal for the first frame to the cable channel interval, and never transmitted for all subsequent frames.

 Meanwhile, upon receiving scrambled data in the cable channel interval, the sync signal detector 49 of the vocoder 40 detects the sync signal from the received scrambled

signal and applies the detection result to the controller 42.

Once the sync signal detector 49 detects the sync signal, the controller 42 switches the third switching block 50 from stage "d" to stage "i".

Consequently, the scrambled signal undergoes the reverse processing of the scrambling, i.e., the signal is descrambled based on the random number output from the random number generator 46. Thus descrambled packet or PCM signal is applied to the operational mode processor 41.

The operational mode processor 41 performs a vocoding or bypass operation based on the operational mode information received from the upper processor 30 and sends the bypassed packet or vocoded PCM signal to the radio channel interval.

A further detailed description will now be given to the scrambling and descrambling operations.

Once the vocoder 40 receives operational mode information and scrambling key information from the upper processor 30, the operational mode processor 41 and the controller 42 generate control signals from the information. That is, the controller 42 stores a scrambling key in the scrambling key seed block 45 and outputs the stored scrambling key to the random number generator 46.

The random number generator 46 generates a random number based on the scrambling key received from the scrambling key seed block 45. The random number is used as information for scrambling or descrambling the input/output communication signals of the vocoder 40. The information corresponds to the positional information of the input/output communication signals of the vocoder 40, the positional information being fed into the scrambler 47 and the descrambler 51.

The scrambler 47 uses the positional information generated from the random number generator 46 to rearrange the position of the communication signal “g” output from the operational mode processor 41 in the unit of bits or bytes. Here, the scrambling performance is higher when rearranging the communication signal in the unit of bits rather than in the unit of bytes. The scrambler 47 combines the rearranged signal “h” with the sync signal generated from the sync signal transmitter 44 and outputs the composite signal to an output “C” of the vocoder 40, thereby sending the scrambled signal on the cable channel.

The descrambler 51 uses the positional information generated from the random number generator 46 to rearrange the scrambled signal “d” on the cable channel interval “D” by the reverse process of the scrambling shown in Table 1, thus descrambling the original signal “j”. An example of the descrambling process will now be described with reference to Table 1.

[Table 1]

Original Position	0	1	2	3	4	5	6	7	8	9
Communication Signal	X0	X1	X2	X3	X4	X5	X6	X7	X8	X9
Random Number	1	3	5	7	2	9	8	4	6	0
Rearranged Signal	X0	X3	X5	X7	X2	X9	X8	X4	X6	X0

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Expediently, it is assumed that the communication signal “g” is rearranged (scrambled) in the unit of 10 bytes, generating ten random numbers “k” ranging from position 0 to position 9. Once a random number is generated as shown in Table 1, in which the first random number is “1”, the communication signal X1 at position “1” is

shifted to the first position (i.e., position "0"). As the second random number is "3", the communication signal at position "3", i.e., X3 is disposed at the second position (i.e., position "1"). Similarly, as the final random number is "0", the communication signal X0 at position "0" is moved to position "9". This procedure obtains the rearranged signals as
5 listed in the bottom row, which signals are scrambled signals.

The descrambling process is a reverse procedure of the scrambling process, which means that the original communication signals can be easily rearranged.

The scrambling start time must be in conformity with the descrambling start time so that the respective vocoders at the transmitter and the receiver of the system can
10 descramble the scrambled signals accurately. That is, considerations of transmission delay of the communication signal in the cable channel interval between the system vocoders are important in descrambling the signals. The methods for solving this problem may depend on the design and configuration of the system. The present invention employs a descrambling method applicable to any system configuration, in
15 which method the sync signal transmitter 44 sends the sync information for the operating time of the scrambler 47 and the descrambler 51 to the second switching block 48 through the cable channels before the scrambler 47 transmits the scrambled signal.

Simultaneously, the descrambler 51 descrambles the scrambled signal by the above-stated descrambling method after detection of the sync signal received from the
20 cable channel "D".

This eliminates inconformity of the driving time between the scrambler 47 and the descrambler 51 that may be caused due to transmission delay of the communication signal between the vocoders at the transmitter and the receiver on the cable channel,

thereby enabling accurate scrambling of the communication signal and descrambling the scrambled signal using the same scrambling key. Here, the sync information has a defined pattern previously negotiated between the system vocoders.

A stepwise description will be given to a voice/data scrambling and descrambling method for a mobile communication system according to the present invention with
5 reference to Fig. 5.

The voice/data scrambling method in a mobile communication system will be described in connection with Fig. 5a.

First, step S101 mode-processes the voice packet or data packet received from the
10 radio channel interval based on the operational mode information supplied by the upper processor 30. That is, the voice packet is vocoded into PCM data, or the voice/data packet is bypassed, based on the corresponding operational mode.

Step S102 generates a random number based on the scrambling key information applied from the upper processor 30.

Step S103 generates a sync signal and sends the generated sync signal to the
15 cable channel interval. After completion of the transmission of the sync signal, step S104 scrambles the mode-processed signal (e.g., PCM data, or bypassed voice packet or data packet) using the random number.

Step S105 sends the scrambled signal in the cable channel interval.

Next, a stepwise description will be given to a method for descrambling the
20 scrambled signal received from the cable channel interval with reference to Fig. 5b.

First, step S201 determines whether a scrambled signal is received from the cable channel interval.

Once the scrambled signal is received, step S202 detects a sync signal from the scrambled signal.

Step S203 determines whether the sync signal is detected, and upon detection of the sync signal, step S204 generates a defined random number based on a scrambling key
5 supplied.

Subsequently, step S205 descrambles the received scrambled signal based on the random number, and step S206 mode-processes the descrambled signal, i.e., PCM or packet based on the operational mode information, thereafter sending the mode-processed packet to the radio channel interval. Here, the corresponding mode enables an
10 operation for converting the descrambled PCM signal to a packet or bypassing the scrambled packet.

As described above, the "device and method for scrambling/descrambling voice/data in a mobile communication system" according to the present invention involves vocoding or bypassing the signal received from a radio channel interval, scrambling the vocoded or bypassed signal using a random number, sending the
15 scrambled signal to a cable channel interval, descrambles the scrambled signal received from the cable channel interval, vocoding or bypassing the descrambled signal, and sending the vocoded or bypassed signal to the radio channel interval, thereby dramatically security of the data in the cable channel interval between the system
20 vocoders and preventing overhearing of the voice.

Furthermore, the application of the present invention is expandable to the radio channel interval between the mobile station and the vocoder, thus providing security of data over all channels.

It is to be noted that like reference numerals denote the same components in the drawings, and a detailed description of generally known function and structure of the present invention will be avoided lest it should obscure the subject matter of the present invention.

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100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400 401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500 501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544 545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560 561 562 563 564 565 566 567 568 569 570 571 572 573 574 575 576 577 578 579 580 581 582 583 584 585 586 587 588 589 590 591 592 593 594 595 596 597 598 599 600 601 602 603 604 605 606 607 608 609 610 611 612 613 614 615 616 617 618 619 620 621 622 623 624 625 626 627 628 629 630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646 647 648 649 650 651 652 653 654 655 656 657 658 659 660 661 662 663 664 665 666 667 668 669 670 671 672 673 674 675 676 677 678 679 680 681 682 683 684 685 686 687 688 689 690 691 692 693 694 695 696 697 698 699 700 701 702 703 704 705 706 707 708 709 710 711 712 713 714 715 716 717 718 719 720 721 722 723 724 725 726 727 728 729 730 731 732 733 734 735 736 737 738 739 740 741 742 743 744 745 746 747 748 749 750 751 752 753 754 755 756 757 758 759 760 761 762 763 764 765 766 767 768 769 770 771 772 773 774 775 776 777 778 779 780 781 782 783 784 785 786 787 788 789 790 791 792 793 794 795 796 797 798 799 800 801 802 803 804 805 806 807 808 809 810 811 812 813 814 815 816 817 818 819 820 821 822 823 824 825 826 827 828 829 830 831 832 833 834 835 836 837 838 839 840 841 842 843 844 845 846 847 848 849 850 851 852 853 854 855 856 857 858 859 860 861 862 863 864 865 866 867 868 869 870 871 872 873 874 875 876 877 878 879 880 881 882 883 884 885 886 887 888 889 890 891 892 893 894 895 896 897 898 899 900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924 925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956 957 958 959 960 961 962 963 964 965 966 967 968 969 970 971 972 973 974 975 976 977 978 979 980 981 982 983 984 985 986 987 988 989 990 991 992 993 994 995 996 997 998 999 1000